NATIONAL BUREAU OF STANDARDS April/1969

# Technical News Bulletin

U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

# Technical News Bulletin

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U.S. DEPARTMENT OF COMMERCE
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*Cover: Various shapes of cold-drawn titanium can now be produced by a method developed at NBS. Leonard Smith, developer of the method, removes a cold-drawn titanium part for use in the NBS linac.* *(See page 88.)*

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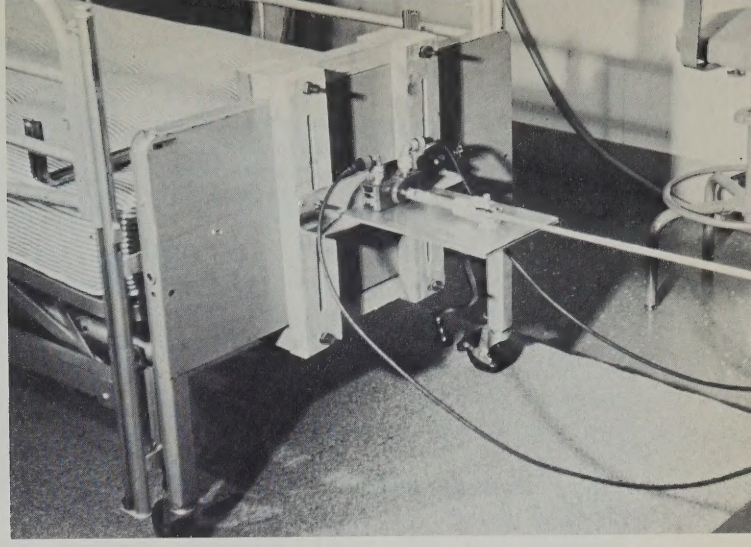
## Performance Data on

# Hospital Floor Coverings



*The testing equipment used to study hospital floor coverings resistance to wheeled-vehicle motion. Using loaded (300 lbs) and unloaded hospital beds, values were obtained in terms of load required to produce and sustain motion.*

While in Most Buildings the Type of flooring used is not critical, hospital flooring requirements are often quite severe. In the operating room, for example, the generation of static electricity is a serious problem. In other areas of the hospital, slip hazard, noise, soil and bacteria transportation, and fire hazard are some of the factors that must be considered in the selection of a flooring material.

To develop performance criteria for hospital floor coverings, NBS recently conducted a field study and laboratory evaluation of their performance. Several tests were also devised to obtain data lacking in the open literature on wheeled-vehicle resistance and resilience of floor coverings as related to fatigue. This work was carried out by W. C. Wolfe and L. F. Skoda of the NBS Institute for Applied Technology and was sponsored by the U.S. Public Health Service.

The main portion of the field study dealt with comparisons between carpet and tile flooring. The field study included reports from staff members of 10 hospitals in the United States and one in Canada, plus data from a hospital and a food-store installation that were observed by the NBS staff.

In general it was found that with carpets there was reduced noise, fewer slips and falls, and less injury in the cases where falls did occur. There was no evidence of increased soil or greater transportation of bacteria when carpet was used. Some difficulty was experienced, however, in rolling heavy wheeled equipment over carpet, and in areas of a great deal of spillage, or "dirty" areas, carpets were not satisfactory.

Several laboratory tests were devised during the course of the study to provide data not available from the field study. In one, a test of resistance to wheeled vehicles, a manual-type hospital bed was used for static and rolling friction measurements. Measurements were made with the bed empty and also with 300 pounds of weight added.

The data were obtained by use of a load-strain testing machine. A load cell was connected to the foot of the bed and attached to the machine crosshead by means of a pulley-and-cable arrangement. Tests were performed at a crosshead speed of 50 centimeters per minute.

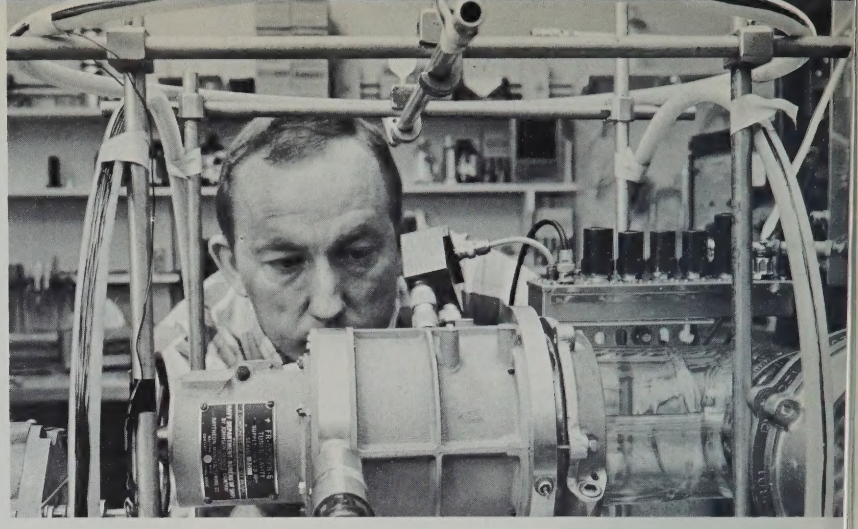
Two types of casters were used in the study. One set was made of hard rubber (recommended for carpet) while the other set was soft rubber (recommended for smooth floors).

The data obtained in these tests included static friction (load in pounds required to produce motion) and rolling friction (load required to sustain motion). The values obtained ranged from 11.1 and 5.3 pounds, static and rolling friction, respectively, for a vinyl asbestos tile covering, hard rubber casters, unloaded bed) to 60.8 and 46.4 pounds for a nylon tufted carpet with sponge vinyl cushion (hard rubber casters, 300-pound load on bed).

In the resilience tests, cement mortar panels, 10 by 10 by 1 in, were used as substrates for floor coverings. Asphalt, vinyl asbestos, and vinyl tiles were cemented to the panels with asphalt cutback adhesive. Linoleum was cemented with linoleum paste. Backed and cushioned vinyl sheet goods were cemented to the panels with a special latex adhesive. Nylon carpet without cushion and with various cushion materials attached were cemented to the panels with latex adhesives recommended by the manufacturers of the products.

Compression-recovery results were obtained by using a compression test-

*continued p. 99*



*C. V. Kurtz readies the echo-box microwave spectrometer for an experiment; wire coils shield it from the earth's magnetic field.*

# ECHO-BOX MICROWAVE SPECTROMETER

## Offers Smooth Scanning and High Sensitivity

A SMOOTH-SCANNING, HIGHLY SENSITIVE microwave spectrometer, which uses a radar echo box as an absorption cell, has been developed [1] by H. E. Radford and C. V. Kurtz of the NBS Institute for Basic Standards. Operating at wavelengths between 3 and 30 cm, the spectrometer is particularly useful for research on unstable molecules; it has enabled Dr. Radford to measure two previously unmeasured spectra of the OH molecule. The laboratory measurement of these OH spectra then led to their detection in space.[2]

The spectrometer was designed primarily for the laboratory measurement of the spectrum of the CH molecule. Many radio astronomers feel that a laboratory measurement of CH would lead to the detection of the molecule in space, thus repeating the successful search for the similar OH molecule.

Such an experiment was started at the Bureau in 1967. Because the location of the CH spectrum was uncertain and no good method of making CH was known, a frequency scanning spectrometer of the highest sensitivity was needed.

The main components of the spectrometer are the echo box, a superheterodyne detector, and a servo-controlled automatic tuning circut. The echo box is a piece of radar test equipment that meets the requirements of an absorption cell for microwave spectrometers—high Q, smooth tuning, and freedom from unwanted resonances. Echo boxes are available from military surplus dealers in various sizes covering the frequency range from 1 to 10 GHz. Their typical form is that of a silver-plated cylindrical mode transmission cavity, one end plate of which is fixed and the other movable by a precision lead screw drive.

To convert an echo box to a spectrometer absorption cavity requires only the change of existing dust seals to vacuum seals by installing rubber O-rings, and replacing the fixed end plate by one designed for high-speed pumping and for Stark modulation. A voltage terminal in the end plate provides Stark modulation by subjecting the specimen gas to an alternating electric field.

Two prototype spectrometers, one operating at S-band, the other at C-band frequencies, have been constructed at NBS. Although usable for measurements on stable molecules, the NBS spectrometers were designed primarily to detect transient molecules generated by gaseous chemical reactions.

For reactions at pressures in the millitorr (1 torr= 133.332 newtons per square meter) range, such as those activated by free atoms, the echo box itself serves as the reaction chamber. The reactant gases, one of which has been partly dissociated by an electric discharge, flow separately in coaxial glass tubes through a central hole in the Stark end plate and mix within the cavity. Examples of these low-pressure reactions are the "atomic flames" of hydrocarbons burning in atomic hydrogen, and the reaction of nitrogen dioxide with atomic hydrogen; the latter is a source of OH molecules.

Reactions that proceed only at pressures in the torr range, or which generate excessive heat or ionization, are confined in an external reaction chamber, from which the reaction products effuse into the echo box through a sampling orifice.

### Detector Circuit

A technical problem posed by any cavity spectrometer is the tendency to saturate microwave lines, which is caused by the energy storage property of a cavity resonator. This problem was solved in the NBS spectrometer by the construction of a single-oscillator type of superheterodyne detection circuit. The circuit permits very low power levels to be used without loss of sensitivity.

In the superheterodyne detector circuit, a local oscillator input to a mixer-preamplifier comes from a carrier oscillator through a directional coupler. The source signal is generated by amplitude-modulating the carrier oscillator output in a balanced crystal modulator, which is driven by a stable 30-MHz oscillator. The echo box is tuned to either of the two sideband frequencies, displaced by 30 MHz from the carrier frequency, and it transmits only this one sideband signal to the mixer-preamplifier. The 30-MHz IF signal generated by the mixer receives 80 dB amplification before being demodulated by a second detector. The modulation component, which is synchronous with the Stark modulation voltage (the desired absorption signal), then receives further amplification in a lock-in detector and is displayed on a pen recorder.

### Automatic Tuning

A servo tuning mechanism serves to make the spectrometer a scanning instrument. The 30-MHz IF signal emerging from the mixer-preamplifier carries both amplitude and phase information. The amplitude information is the microwave absorption signal, which the detector recovers and sends on to the pen recorder. The phase information is in the form of a phase shift of the IF signal with respect to the 30-MHz modulation oscillator signal; its magnitude depends on the degree to which the echo box cavity is mistuned from the source frequency. A dc error voltage proportional to the IF phase shift is generated by a 30-MHz phase-sensitive detector. The error voltage is applied to a servo motor that adjusts the echo box lead screw; this keeps the echo box tuned to the oscillator frequency.

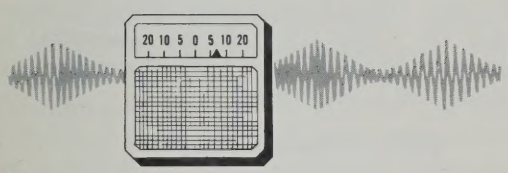
### Calibration

The microwave line of formaldehyde vapor at 3225 MHz, with an absorption coefficient of $7.0 \times 10^{-7}$ cm$^{-1}$, was observed to determine the sensitivity of the S-band version of the echo-box spectrometer. At a Stark modulation frequency of 30 kHz and lock-in detector time constant of 1 s, the minimum detectable absorption coefficient, determined from the measured signal-to-noise ratio, was $1.3 \times 10^{-10}$ cm$^{-1}$.

According to the formaldehyde calibration, an increase of the spectrometer time constant to 3 s would make the CH spectrum detectable. Using this time constant, searches were made for the spectrum but with no results. It is thought that the inability to produce CH molecules in sufficient concentrations is the reason for the unsuccessful searches.

The two previously mentioned spectra of OH, however, were measured with the spectrometer. These were the 4.7 GHz spectrum of the $^2\Pi_{1/2}$, $J=1/2$ level and the 6.0 GHz spectrum of $^2\Pi_{3/2}$, $J=5/2$ level. Lowest in energy of the excited rotational levels of OH, these two levels play special roles in maser theories of interstellar OH emission.

[1] Radford, H. E., Scanning microwave echo box spectrometer, Rev. Sci. Instr. (to be published).
[2] New radio line found at microwave wavelengths, IEEE Spectrum 5, No. 6, 126 (June 1968).




# STANDARDS AND CALIBRATION

## STANDARD FREQUENCY AND TIME BROADCASTS

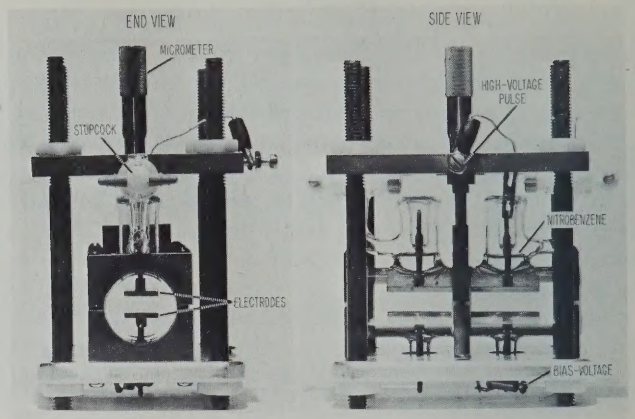
WWV—2.5, 5.0, 10.0, 15.0, 20.0, and 25.0 MHz
WWVH—2.5, 5.0, 10.0, and 15.0 MHz
WWVB—60 kHz

Radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast signals that are kept in close agreement with the UT2 scale by making step adjustments of 100 ms as necessary. Each pulse indicates that the earth has rotated approximately 15 arcseconds about its axis since the previous one. The pulses occur at intervals that are longer than one second by 300 parts in $10^{10}$ due to an offset in carrier frequency coordinated by the Bureau International de l'Heure (BIH), Paris, France. Adjustments are made at 0000 UT on the first day of a month. *There will be no adjustment made on May 1, 1969.*

Radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses derived from the NBS Time Standard (NBS–III) with no offset. Step adjustments of 200 ms are made at 0000 UT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be no adjustment made on May 1, 1969.*

## LASER-LIGHT APPLIED TO

# HIGH-VOLTAGE PULSE MEASUREMENTS




*Kerr cell shown installed in a spring-loaded, micrometer-driven holder. This type of cell has been used to measure pulse voltages as high as 100 kV with accuracies comparable to pulse-divider measurements.*

A RECENT STUDY [1] AT THE NBS Institute for Basic Standards has shown that modulated laser light can be used for accurate measurements of very short (microsecond) high-voltage pulses. A calibration procedure for the system was also devised that eliminates reference to pulse voltage-divider measurements. This calibration method is of particular interest since it provides an independent check at high voltages on voltage-divider calibration methods.

Modulation of the laser light is induced by passing the light between high-voltage electrodes immersed in a dielectric liquid (Kerr cell). The study, conducted by E. C. Cassidy and H. N. Cones of NBS in a joint effort with D. C. Wunsch and S. R. Booker of the Sandia Corp. (Albuquerque, N. Mex.), has shown that the Kerr-cell system can be used for measurements of pulses as high as 100 kV to an accuracy within 1 percent. The work was sponsored in part by the Atomic Energy Commission.

High-voltage pulses are usually measured by use of resistive or capacitive voltage dividers. Calibrations of these devices are obtained either by extrapolation of low-voltage measurements of the voltage division ratio or by comparison at high voltage with a "standard" divider that was at some point calibrated at low voltages. The division ratio, therefore, is always somewhat uncertain in high-voltage applications.

The Kerr pulse-measuring system offers several unique advantages over conventional pulse voltage dividers including the following: Measurement resolution increases with the magnitude of the pulse voltage being measured; the system has a linear frequency response to about 100 MHz; and the measuring circuit is electrically isolated from the high-voltage circuit, thus avoiding many of the errors inherent in resistive and capacitive divider techniques. Because of these desirable characteristics, it is anticipated that the Kerr system will be useful as a standard for calibration of pulse voltage dividers.

### Apparatus

A Kerr cell having two parallel-plate nickel electrodes and filled with nitrobenzene, which is highly purified and sealed in the cell by W. A. Bagley of the High Voltage Section, is installed in the path of a helium-neon laser beam. The beam is directed through the cell along the length of the plate-electrodes. Prism polarizers, "crossed" with respect to one another, are placed in the light path at each end of the Kerr cell, so that initially no light is transmitted by the system. When high voltage is applied across the cell electrodes, the state of polarization of the laser light is altered (the Kerr effect), thus causing light to be transmitted through the system. The cells are constructed at the NBS Instrument Shops Division under the supervision of E. Deleonibus and C. E. Taylor.

### Pulse Measurements

The intensity (I) of the transmitted light, which is detected by a photomultiplier and recorded on an oscilloscope, depends on the strength of the electric field imposed by the applied voltage. The relative intensity $(I/I_m)$ (where $I_m$ is the maximum intensity transmitted by the system) of the transmitted beam varies with the relative electric field strength $(E/E_m)$ (where $E_m$ is the field strength that produces the first transmission maximum, $I_m$). The transmitted intensity oscillates between maximum and minimum values in response to a changing electric field. Maximum transmission occurs when $(E/E_m)=1$, $\sqrt{3}$, $\sqrt{5}$, etc., and minimum transmission occurs when $(E/E_m)=0$, $\sqrt{2}$, $\sqrt{4}$, etc.

These electro-optical modulations of the laser-beam in-

tensity are utilized for time-resolved measurements of the instantaneous amplitude V of an applied high-voltage pulse, as follows:

$$V = (E/E_m)\ V_o,$$

where the cell constant $V_o$ is determined in calibration of the system. The relative strength $(E/E_m)$ of the field imposed by the high voltage is determined from the time-resolved oscilloscope record of a photomultiplier's response upon application of the high voltage across the Kerr cell, by counting the number of maxima and minima traced on the record prior to the instant of measurement and by reading the value of $(I/I_m)$ at the instant of measurement.

In the system used at NBS, a direct voltage is applied that biases the Kerr system to its first transmission minimum and adds to the voltage difference across the Kerr cell. This direct voltage serves several purposes: It enables independent calibration of the system without reference to pulse divider measurements; it reduces the danger of internal arcing within the cell by "conditioning" it for application of a high voltage; and it increases the sensitivity of the Kerr-cell technique (more oscillations of the transmitted beam intensity are produced by a given pulse voltage).

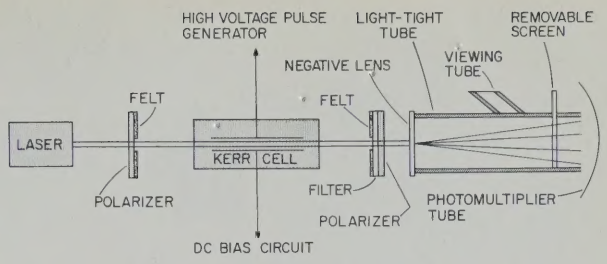
## Calibration

Thus far, NBS has developed and is evaluating several methods of calibrating the Kerr pulse-measuring system. Calibrations, obtained by reference to calibrated resistive divider measurements, have demonstrated the Kerr electro-optical method to be at least as accurate as conventional voltage-divider techniques of pulse measurement. This result has been verified with several different cells installed in the Kerr system, by comparison of pulse-divider measurements with simultaneous Kerr system measurements of voltages ranging from 10 to 100 kV.

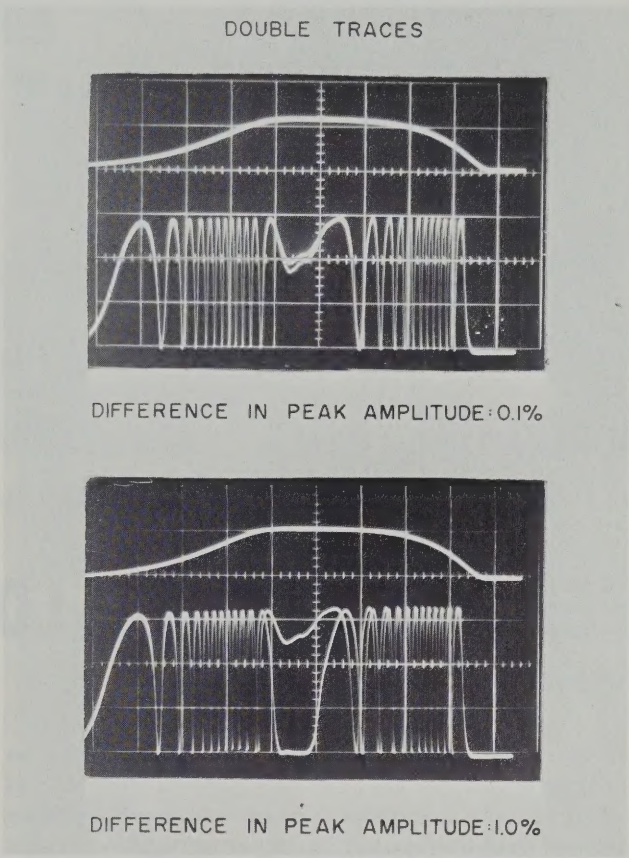
Independent calibrations, obtained without reference to pulse-divider measurements, have also been achieved with several different cells installed in the system. These calibrations are obtained by detection and measurement of the direct voltage (the cell constant mentioned earlier) that produces the first transmission minimum. Results from repeated measurements with several different Kerr cells installed in the system have demonstrated this independent method to be reliable to within 1 percent, in spite of difficulties arising from nonuniformity in the electric field imposed by the bias voltage.

Work is continuing at NBS on the Kerr cell system to obtain increased accuracy in the independent calibration procedure and for extension of the system's measurement capability to 300 kV.

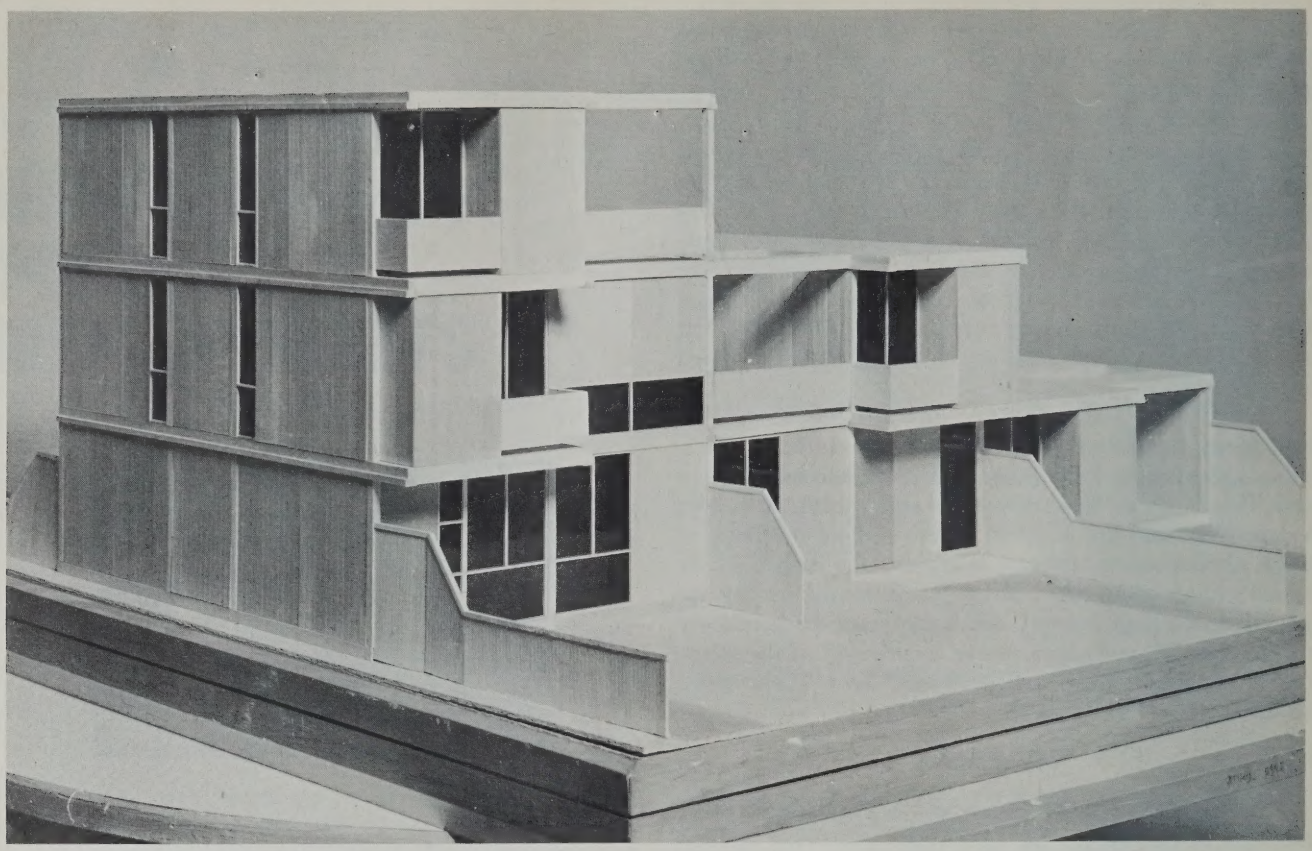
[1] Cassidy, E. C., Cones, H. N., Wunsch, D. C., and Booker, S. R., IEEE Trans. Instr. Meas. (Dec. 1968).




LAYOUT OF THE OPTICAL SYSTEM




*Above: Schematic of the Kerr system used at NBS for measuring high-voltage pulses.*
*Below: Typical oscilloscope records from simultaneous voltage divider and Kerr system measurements of rectangular pulse voltages. The top traces in each record are the voltage-divider measurements. The bottom traces are the Kerr system's photomultiplier response signals. Two pulse-voltage measurements are superimposed in each of these records to demonstrate the superior measurement resolution afforded by the Kerr system. Top: Peak amplitudes of the measured pulses differed by 0.1 percent—superimposed voltage-divider records cannot be distinguished, though the Kerr system shows measurable difference. Bottom: Peak amplitudes of the measured pulses differed by 1 percent—the Kerr system shows nearly a full scale difference, with still no detectable difference for the voltage divider.*



*Scale model of the low income housing now under construction in the Phoenix Project, Detroit, Mich.*

# PERFORMANCE OF LOW-INCOME HOUSING

## Phoenix Project Studied

Applications of New Methods and Materials to building technology are often hampered because lack of experience with new systems prevents issuance of building permits. Recently, however, an important step in the solution to this problem was taken when the NBS Institute for Applied Technology conducted a full-scale performance evaluation of the low-income housing to be used in the Phoenix Project now under construction in Detroit, Mich. The study, which was directed by E. O. Pfrang and sponsored by the Department of Housing and Urban Development, gave assurance that the system did not sacrifice safety for economy. In view of the findings by NBS, the city of Detroit waived building code requirements and issued a permit for the project.

The tests have demonstrated that performance criteria can be developed for the confident evaluation of the safety and structural adequacy of building systems. The experience gained in the project also provides an important new approach for obtaining acceptance of new methods and materials that should be valuable in other cities. It is possible that such studies could lead to revisions of building codes that in turn could lead to a revolution in building technology.

The building system to be used in this project employs revolutionary concepts developed by Neal Mitchell of Harvard's Graduate School of Design. It makes use of prefabricated lightweight components that can be erected quickly and easily into the frame of an expandable single-story or multi-story building. The frame is made of reinforced cellular concrete to which a variety of materials such as brick, steel, wood, glass, aluminum, or fiberglass can be attached for walls. The components are designed so that two men can lift and place each section.

One of the revolutionary features of this new project is that it was designed as a building system. The strength and stiffness depend on interactions between the basic struc-

ture and other elements that are normally considered to be architectural. Usually, buildings are designed neglecting this interaction. A unique feature of this system is dependence upon the strengthening effect of the partition walls. As these walls are not usually relied upon to add strength and support to the structure this aspect of the system needed to be verified by testing. In addition, Detroit's building code did not have provisions for this concept (nor do most other cities) and, understandably, city officials were reluctant to waive requirements on the basis of analysis alone.

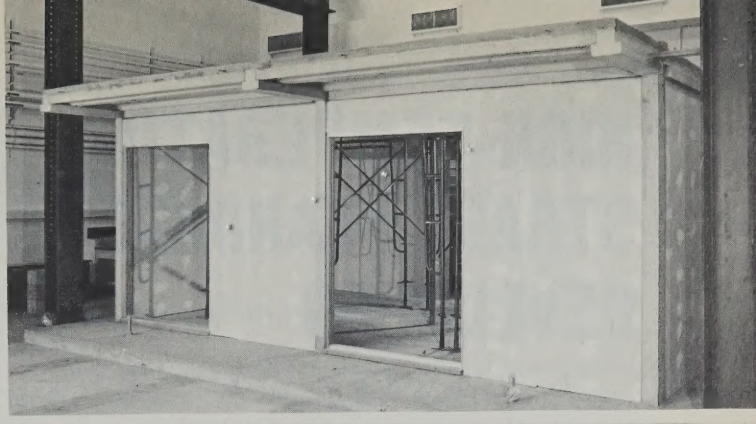
The manner of testing was chosen to simulate the structural response of a three-story building when subjected to live (living beings), dead (furniture), and wind loads. The pressure needed to simulate these loads was provided by hydraulic jacks and 10- by 12-ft air bags. Readings were taken by electronic equipment and then fed into a computer, where they were analyzed. Additional tests were performed on the system components and materials used in the test structure such as short- and long-term column tests, and repeated-load tests on the main structural beams of the system.

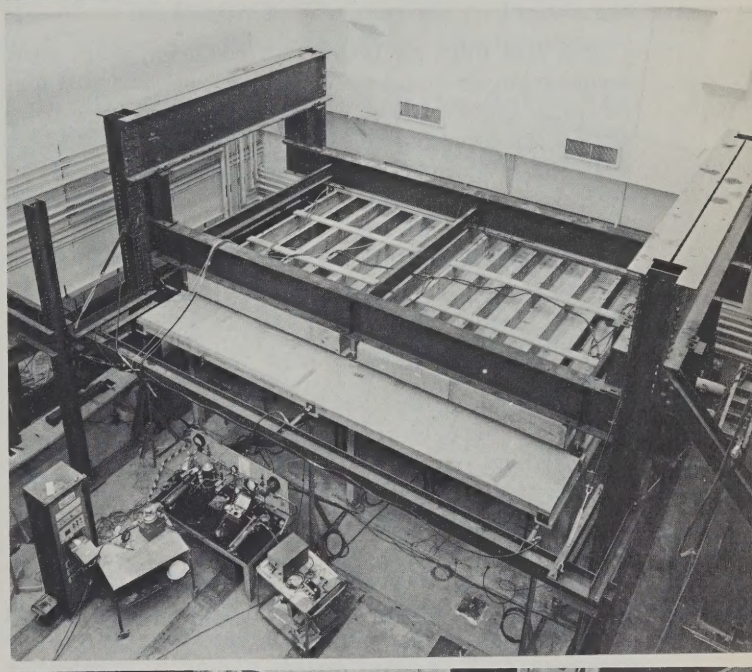
A total of 18 different types of load tests were performed. Of these, 17 involved extensive measurements and recording of loads and structural deformations. Approximately 40 000 measurements were recorded, automatically reduced, and plotted by the computer.

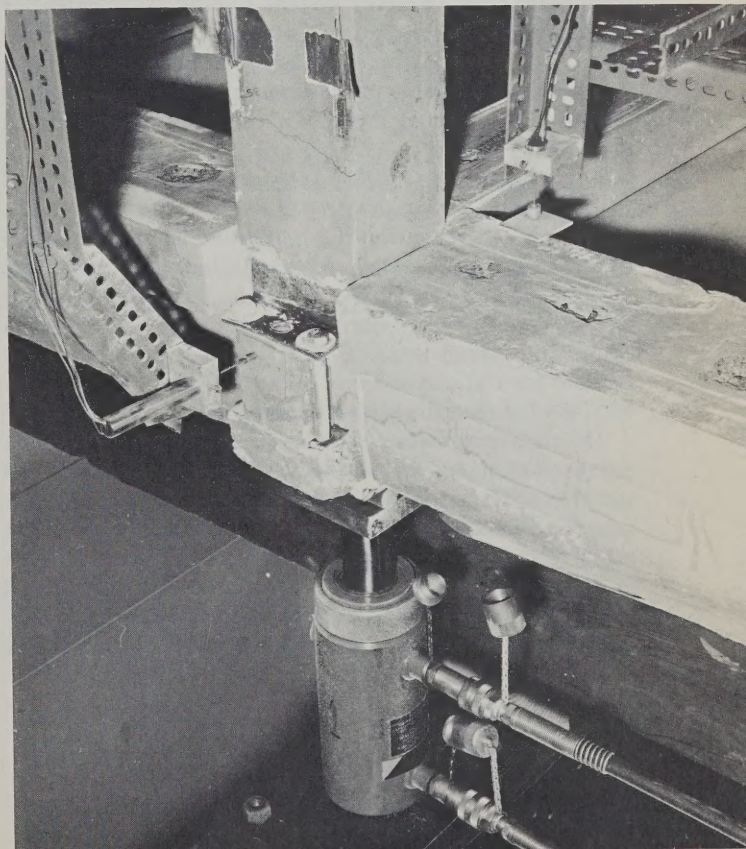
The computer output consisted of a complete tabulation of results along with more than 1000 curves of measured deformations plotted as a function of applied load. In addition to the data acquired by the automatic digital system, a continuous plot of a critical deflection parameter versus applied load was maintained for all tests by an automatic X-Y plotter. This was used along with mechanical dial gages to provide a secondary and independent check on the accuracy of the automatic equipment.

It was concluded that the system performed well in terms of the performance criteria that were set for its evaluation. As a system it exhibited strength and stiffness far in excess of service requirements.

The testing of a complete unit also verified that the walls of the system behaved as integral parts of the structure. They provided most of the stiffness of the system with respect to lateral loads, and a significant portion of the stiffness against vertical loads.





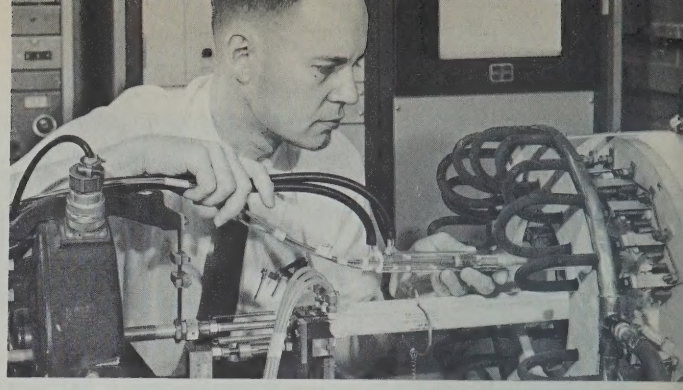


*Above: A full-scale, one-story portion of the Neal Mitchell low-income housing system evaluated by NBS.*
*Center: A full-scale unit of the Phoenix Project housing system is shown here with the test equipment installed. Over 40 000 measurements were made on the unit to determine its performance.*
*Below: A column load simulation test was one in a series of tests on the Neal Mitchell housing system. Pressure is applied by the hydraulic jack (top) as strain gages (attached to wires) measure deformations.*



335-770 O—69——2

# HIGH-TEMPERATURE STRAIN STANDARD DEVELOPED



*C. H. Melton inserts the extensometer in the furnace.*

There Has Been an Increasing Need for strain measurements on structural materials and components at temperatures above those at which existing strain-measuring devices can accurately function. The development of high-temperature strain gages, however, has been hampered by the lack of a reliable reference for use in evaluating new or improved devices and materials.

To supply this needed reference, the Institute for Basic Standards, working under U.S. Air Force sponsorship, recently developed an extensometer system for operation at temperatures of up to 1923 K (1650 °C). Designed and constructed by R. L. Bloss, J. T. Trumbo, C. H. Melton, and J. S. Steel, the system has good range, high resolution, and small random errors. It should lead to better usage of materials and improved structural designs by providing a means for measuring strain in structural components when they are subjected to loads at high and rapidly changing temperatures.

The main component of the NBS-developed extensometer is a capacitive sensor that has an effective area dependent upon the relative position of a movable grid and two stationary grids. A lever system is used to transfer the motion due to strain from a specimen to the capacitive sensor. This is accomplished by a stationary leg, which is attached to the body of the extensometer, and a movable leg that is connected through a push rod to the sliding grid.

A specimen's deformation (or strain) causes the leg, and thus the grid, to move relative to the two stationary grids. This varies the capacitance; hence, the change in capacitance becomes a measure of the strain on the specimen.

A capacitance-to-voltage converter, in which output voltage varies linearly with capacitance, is used as an indicator. The system was designed so that it provides direct readout for static extensions (or strain) and terminal connections for recording dynamic extensions.

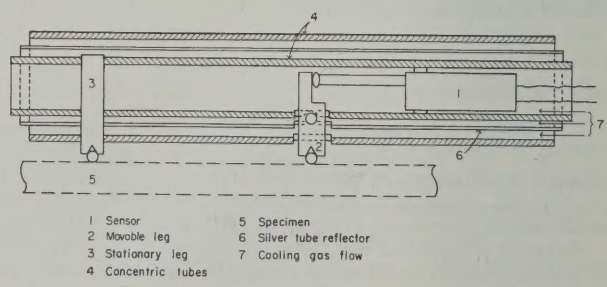
The capacitive sensor is housed inside a cylindrical tube that is surrounded by a silver radiation shield. A transparent concentric tube encases this apparatus. This arrangement allows cooling air to be passed through the tubes to maintain the interior tube and sensing element at a moderate temperature.

The system was calibrated by means of a specially designed apparatus that used a micrometer to produce and measure displacements. The micrometer was attached so that it could be made to vary the distance between two blocks by a known amount. The extensometer was attached to the blocks by V-notches in the extensometer legs resting on cylinders that were cemented to the blocks. Capacitance was then obtained as a function of the known displacements.

The system has been tested under static and dynamic mechanical and thermal conditions. The static tests involved maintaining a constant temperature while comparing the reading from the extensometer with displacements produced and measured by a precision micrometer. These tests were conducted at temperatures up to 1088 K (815 °C). In the dynamic testing, the output voltage from the readout circuit was recorded while the extensometer was subjected to periodic displacements under constant and transient temperature conditions. These tests were carried out at temperatures up to nearly 1673 K (1400 °C).

The results of the tests showed that the system has a range at least 2.1 mm, has a resolution of $2.5 \times 10^{-4}$ mm, has random errors of about $5 \times 10^{-4}$ mm, and is linear to within about 0.1 percent of the range.

The performance at the highest test temperatures used indicates that the extensometer system should be usable at higher temperatures, probably to 1923 K (1650 °C). The close agreement of results from static tests conducted before and after the dynamic tests further confirms the ability of the extensometer to operate in extreme thermal environments without degrading its performance.




*Cross-sectional view of the extensometer.*

# CONFERENCE *Briefs*

## SYSTEMS ANALYSIS FOR SOCIAL PROBLEMS

Scientists, administrators, and Government officials will meet for 3 days next month to discuss ways of using the scientific methods of systems analysis to help solve some of the Nation's current social problems.

This meeting, the Symposium on Systems Analysis for Social Problems, will be held on May 26–28, 1969, at the NBS site in Gaithersburg, Md. It is sponsored by the Washington Operations Research Council (WORC), NBS, the President's Office of Science and Technology, the Urban Institute, and the Cost-Effectiveness Section of the Operations Research Society of America.

The Symposium will focus on urgent problems in such fields as education, city management, transportation, public safety, and environmental quality. Leading national authorities from research centers, universities, industry, Congress, and Federal, State, and local governments will bring their systems analysis expertise to bear on defining and solving these problems.

Previous symposiums sponsored by WORC and concerned with logistics, urban problems, cost-effectiveness applications, war gaming, and time sharing have met with widespread interest and success. More than 500 people are expected to attend the Symposium.

The Symposium is being planned under General Chairman Alfred Blumstein of the Institute for Defense Analyses, Arlington, Va. The program is under the chairmanship of Murray Kamrass, also of the Institute for Defense Analyses.

Symposium registration forms and details concerning the program can be obtained from Eugene P. Visco, Symposium Registration Cochairman, GEOMET, Inc., 12280 Wilkens Ave., Rockville, Md. 20852 (301–933–5525). The registration fee is $50, which includes three lunches, a banquet, and a copy of the Symposium *Proceedings*.

## ACCG CRYSTAL GROWTH CONFERENCE

A conference that will encompass all aspects of the theory and practice of crystal growth will be held at the Bureau August 11 through 13. The Conference on Crystal Growth will be jointly sponsored by the American Committee for Crystal Growth (ACCG) and NBS. Sponsorship of this meeting is in line with the policies of the ACCG to foster and coordinate activities that deal with crystal growth theory and practice in the United States.

Sessions will be devoted primarily to impurity distribution; new results in vapor-phase growth; melt and solution growth; polymers (including selenium and tellurium compounds); and eutectics, dendrites, and morphological stability.

Contributed papers are being solicited. Two-hundred word abstracts for 15-minute papers should be sent before May 15 to the Conference Chairmen, K. A. Jackson and R. A. Laudise, Bell Telephone Laboratories, Inc., Murray Hill, N.J. 07974.

All other meeting information may be obtained from the Conference Secretary, C. S. Sahagian, Air Force Cambridge Research Laboratories, L. G. Hanscom Field, Bedford, Mass. 01730.

## SCHEDULE NBS-SPONSORED CONFERENCES

*Each year NBS sponsors a number of conferences covering a broad range of topics in science and technology. The conferences listed below are either sponsored or cosponsored by NBS and will be held at the Bureau's Gaithersburg, Md., facility unless otherwise indicated. These conferences are open to all interested persons unless specifically noted. If no other address is given, inquiries should be sent to the person indicated below in care of NBS Special Activities Section, Room A600, Administration Building, Washington, D.C. 20234.*

**Fundamental Aspects of Dislocation Theory.** Apr. 21–25. Contact: J. Simmons (NBS Metallurgy Division).

**NRCA–NBS Joint Symposium on Roofing.** Apr. 29–30. Cosponsor: National Roofing Contractors Association. Contact: T. H. Boone (NBS Building Research Division).

**Symposium on Health Problems.** May 14–16. Cosponsor: Operations Research Society of America (Health Section). Contact: Lloyd Burden (NBS Technical Analysis Division).

**10th Symposium on Electron, Ion, and Laser Beam Technology.** May 21–24. Cosponsors: University of Maryland, Institute for Electrical and Electronics Engineers (GED), American Vacuum Society. Contact: L. Marton (NBS).

**Symposium on Systems Analysis for Social Problems.** May 26–28. See above.

**Conference on Crystal Growth.** Aug. 11–13. Sponsor: American Committee for Crystal Growth. Contact: C. S. Sahagian, Air Force Cambridge Research Laboratories, L. G. Hanscom Field, Bedford, Mass. 01730.

**Dental Research—50th Anniversary.** Oct. 6–8. Cosponsor: American Dental Association. Contact: W. T. Sweeney (NBS Polymers Division).

# SHAPING INTRACTABLE METALS

## NBS Draws Titanium Foil Domes

INSTRUMENTING AND EQUIPPING A LINEAR accelerator calls for solving many extraordinary engineering and fabrication problems. A unique problem encountered at the NBS Center for Radiation Research was to make water-cooled "windows" that would retain a vacuum but pass an intense electron or particle beam.

Titanium was selected for the window material because of its high strength-to-mass ratio and compatibility with other materials.[1] However, the characteristics of this metal made forming its foil into spherical sections a difficult operation. Leonard Smith of the NBS Instrument Shops did this by cold-drawing, a process not successfully used before in forming titanium into pieces of such complexity.

### Linear Accelerators

Linear accelerators—"linacs"—are used to investigate the structure of matter by irradiating a sample of the material, altering its characteristics in a way that can be related to hypothesized changes. Essentially a linac is a long tube with many electron accelerating stages along its length. The interior of the tube is evacuated, so its end must be sealed off by a window that is relatively transparent to the beam.

Windows for low-power linacs can be fabricated of easily worked materials, but the high-power machines now in use require the window to be cooled to prevent damage from the intense pencil-like beam of radiation. The NBS linac is such a machine, operating at the 100 MeV level and having a 1-mA beam current. The window must be strong enough to withstand the pressure, must be unaffected by radiation, and must pass the beam with a minimum of heating and minimal disturbance of the beam.

Titanium foil was selected for this application partly because its high strength-to-mass ratio made possible sufficiently tough membranes that are thin enough to be highly transmissive and little affected by heat generated by the beam. Another reason for the selection is that titanium does not interact with the other materials used in the cooling system.

### NBS Window

The first NBS window was installed in 1966 and is one of the several identical ones in use with the linac today. Others like it have been supplied by the Bureau to two other radiation laboratories.[2]

The window consists of a flange, on which are clamped together rings bearing rounded foil membranes and other window parts. A pair of membranes, a domed one and a derby-shaped one, is at each end of a somewhat spherical cavity. Cooling water is circulated across the 0.050-inch gap between each pair at a speed of 15 feet per second. Since the water is under pressure of 80 pounds per square inch and since all of the membranes bulge outward from the cavity, they are kept under tension by pressurizing the cavity with helium at 100 pounds per square inch. The assembled window is installed by bolting its flange to the end of the accelerator tube.

### Drawing Titanium

Titanium is such a difficult metal to work that little information on how to form it was available. Cold-drawing titanium foil by means of dies seemed to be the best method to use, but essential details had to be found by trial and error.

The first experimental dies drew brass well, but titanium of 0.004 inch in nominal thickness puckered around the edge of the curved surface and sometimes split on top. This was attributed in part to thickness variations as great as 0.0005 inch in the stock, testimony to the difficulty of working titanium.

To combat puckering and splitting, Mr. Smith experimented with several variables and with drawing the foil in more than one step, using molybdenum disulfide as a die lubricant. The first step was to draw the 0.004-inch foil into a shape like a narrow-brimmed straw hat (for the dome) and into one like a top hat (for the "derby") by pairs of dies in a press.

The second step, hydroforming a spherical surface of 2-inch radius on the top of the hat, at first produced only defective pieces. This process consisted of clamping the brim of the hat around the opening of a female die and with the hydraulic fluid pressing the top of the hat down into the die, forming it to the same radius. A succession of experimental dies was tried in an attempt to produce perfectly-domed pieces. The problem finally yielded to allowing controlled creep of the foil in the hydroforming step, both from the side to the edge of the dome and from the flange to the side.

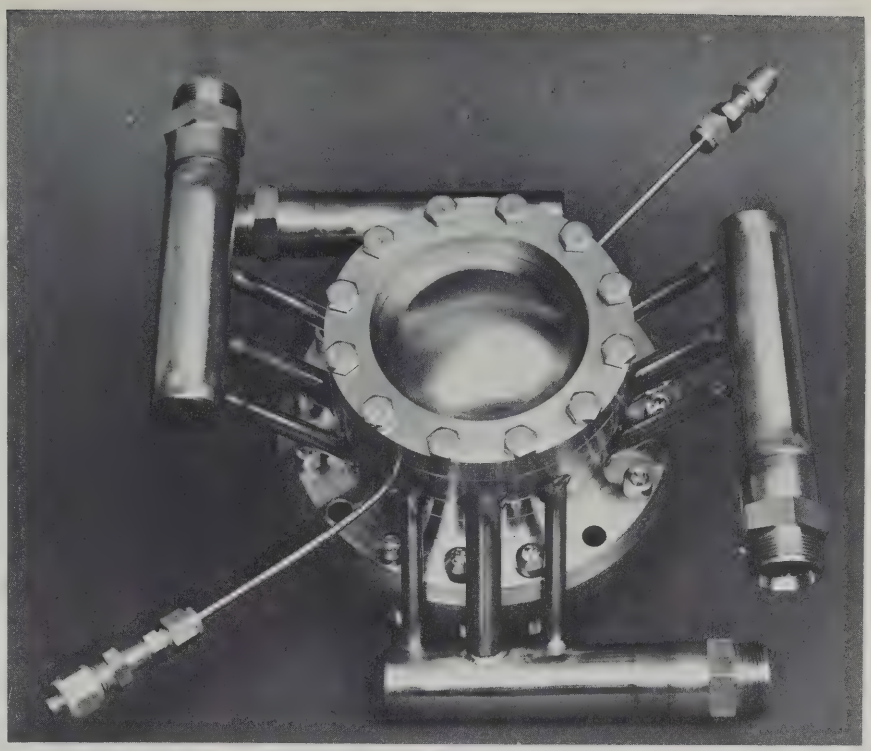
Obtaining the desired creep in the second step required modifications to the dies used in the first step. Creep from the flange to the side was obtained only when the edge at the opening of the female die used in the first step was rounded to experimentally determined dimensions. Creep around

the edge of the dome was found to occur evenly and without puckering only if the penetrating edge of the male die was rounded to the radius later to be imparted to the dome. Creep in the hydroforming step was eased by lubricating the surfaces and was controlled by clamping the flange with a uniform, experimentally determined pressure. As a result of this step, the thickness of the foil was reduced to about 0.003 inch.

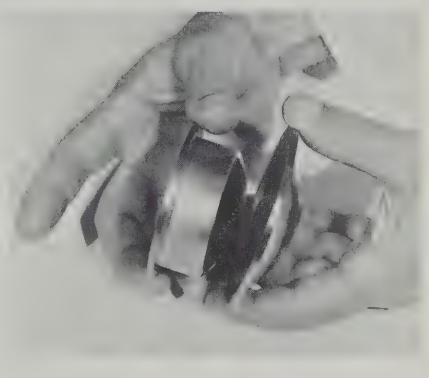
One shape obtained by this method resembles a squat, narrow-brimmed, round-topped hat. It was mounted on a mandrel and a 3⅛-inch diameter section of the spherical surface was carefully cut off in a lathe. This was then arc-welded in an inert gas to a precisely dimensioned rim, using techniques developed at the Bureau.[3] The finished dome looks somewhat like a small, opaque headlight lens with a thickened rim.

The other shape, a narrow-brimmed "derby" 2½ inches across the sides, was mounted on its cutoff mandrel, and the dome and most of the side were separated from the flange. This rimless derby was then welded to its mounting rim. The lenses and derbies were matched to allow for a 0.050-inch gap between them when assembled.

The rims on which the foils were mounted had a fine surface finish and were protected from subsequent damage. When they and the other ring-like components of the window were assembled and clamped together on the flanged base, airtight metal-to-metal seals were obtained. Other components needed to complete the window were the intake and exhaust plenums and their tubes for the coolant for each membrane pair, as well as tubes for purging and pressurizing the cavity of the window.



*Above: The "window" between the atmosphere and the vacuum inside the NBS linear accelerator is bolted to the linac output end. One of its titanium foil membranes is visible inside it; a stream of cooling water flows between this and a concentric membrane 0.050 inch beneath it.*



*Below: The titanium foil membranes for the NBS linear accelerator are assembled in this relationship.*

### Beam Dump

Another accelerator component requiring a water-cooled window is the beam dump, in which the beam energy is dissipated and from which the heat generated is removed by circulating coolants. Because the beam is more dispersed in density at this point than at its origin, a larger window, with a diameter of about 8 inches, is used. It also has water flowing between the surfaces of its single pair of membranes at a speed of 15 feet per second. The foil surfaces bulge outward to contain in tension the pressure of the water within the dump. Any energy penetrating the 36 inches of water is expended in a 3-inch wall of lead, which is cooled by water flowing through ducts within it.

The use of a heavier foil with a thickness of 0.011 inch for the dump windows to obtain dimensional stability was acceptable, because the more dispersed beam could not overheat the foil despite the greater thickness. The dump windows were fabricated by the same techniques as were the smaller windows; solutions to problems resulting from their greater size and thickness were found by experimentally adjusting forming pressures, clamping pressures, and radii.

[1] Penner, S., Handling high power electron beams, IEEE Trans. Nucl. Sci. NS–14, 908–917 (June 1967).

[2] U.S. Patent No. 3,375,387, Fluid Cooled Multi-Foil Radiation Beam Window for High Power Beam Tubes, assigned to the Secretary of Commerce.

[3] Welding technique for high-vacuum equipment, NBS Tech. News Bull. 52, 104–106 (May 1968).

# NSRDS NEWS

*This column regularly reports significant developments in the program of the National Standard Reference Data System, which was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The System is administered and coordinated by the NBS Office of Standard Reference Data.*

### Mean Activity Coefficients of Electrolytes

NSRDS-NBS 24, *Theoretical Mean Activity Coefficients of Strong Electrolytes in Aqueous Solutions from 0 to 100 °C*[1] ($4.25), by Walter J. Hamer, is the most recent publication in the NSRDS series. The compilation presents values of the mean activity coefficient, a basic physical-chemical parameter that measures the departure of a real solution from ideality, for strong electrolytes in water, as calculated from seven theoretical equations widely referred to in the literature.

Coefficients are given, on both a volume and a weight basis, for 28 selected values of ionic strength from 0.0001 to 0.1, at every 5 deg C from 0 to 100 °C, for completely dissociated electrolytes with valences 1-1, 1-2 (or 2-1), 1-3 (or 3-1), 1-4 (or 4-1 or 2-2), 2-3 (or 3-2), 2-4 (or 4-2), 3-3, 3-4 (or 4-3), and 4-4. The theoretical equations employed are those of (1) Debye and Hückel, frequently referred to as the limiting law of Debye and Hückel, (2) Güntelberg, (3) Davies, (4) Scatchard, (5) Bjerrum, (6) a modified or extended Güntelberg expression, and (7) a modified or extended Scatchard expression.

The introduction to the compilation briefly discusses the relations betwen chemical potentials, activities, and activity coefficients; the theoretical expressions used for the calculations; and the uncertainties in the resulting values. This is followed by 130 tables of activity coefficients and 5 auxiliary tables that list estimated limits of uncertainty of the calculated coefficients and give corrections to be applied when an alternative value for the dielectric constant of water is adopted.

Only in rare cases do the calculated coefficients agree exactly with the experimental values. However, they are useful as an aid in rapid interpretation of discussions in the literature where one encounters such statements as: "Activity coefficients were calculated by the limiting law of Debye and Hückel," "Bjerrum ion sizes were used to calculate activity coefficients," or "Scatchard has suggested that a better average of the higher virial coefficients would be provided by a $1+1.5m$½term." They can also be used to estimate an activity coefficient when an experimental value is not available. Information of this kind is relevant in a broad range of investigations. Some examples include work on thermodynamic quantities, chemical statics and kinetics (effective concentration is directly related to activity coefficient), and the study and technology of batteries and electrodeposition.

### Transition Probabilities for Ba I and II

NBS Technical Note 474, *Critically Evaluated Transition Probabilities for Ba I and II*[1] (30 cents), by B. M. Miles and W. L. Wiese, is a special compilation developed in response to much recent interest in the barium spectrum. The data are arranged in tables according to transition arrays. The transition probability for spontaneous emission, the absorption oscillator strength, and the line strength for each line are given along with the wavelength, the statistical weights, log gf, and the energy levels of the upper and lower states. In addition, the estimated accuracy and the source are indicated, and the justification for choosing the adopted data and the accuracy rating are discussed.

### High Temperature Rate Data

The second report in a series of critical evaluations on gas phase reaction rate data has been issued by D. L. Baulch, D. D. Drysdale, and A. C. Lloyd of the High Temperature Reaction Rate Project, University of Leeds, England. The document treats the following eight reactions of hydrogen and oxygen:

$H_2+O\rightarrow OH+H$
$OH+H\rightarrow H_2+O$
$H_2+OH\rightarrow H_2O+H$
$H+H_2O\rightarrow H_2+OH$
$H_2O+O\rightarrow OH+OH$
$OH+OH\rightarrow H_2O+O$
$H_2O+M\rightarrow H+OH+M$
$H+OH+M\rightarrow H_2O+M$

As in the first report, the data sheet format is used. The rate data are tabulated for each reaction, together with an indication of the experimental method used and

the evaluator's comments that pertain to the values listed. A discussion and a bibliography are provided for each reaction.

This work is part of the High Temperature Rate Data Project supported by the U.K. Office of Scientific and Technical Information, which administers the British Data and Information Program. This Office is the U.K. equivalent to the NBS Office of Standard Reference Data, which administers the U.S. NSRDS program. For further information about the work of the Leeds Group or copies of reports, contact Dr. D. L. Baulch, School of Chemistry, The University, Leeds, 2, United Kingdom.

## First U.S.S.R. Standard Reference Data Publication

*Thermophysical Characteristics of Substances* is a collection of papers published by the Soviet equivalent of the U.S. National Standard Reference Data System. It is the first in a series of publications designed to provide systematic publication of relevant information concerning thermophysical properties of materials.

The U.S.S.R. State Service for Provision of Information on Standards, which deals with the fundamental physical properties of materials, was created in 1965 by a resolution of the Cabinet of the U.S.S.R.[2] Its mission is to coordinate and direct the activities of research institutions working on the determination of properties of substances, and to receive and distribute relevant scientific data obtained by calculation or experimentation. One of the basic functions of this program is to publish and disseminate collections of data, monographs, and reviews of publications dealing with properties of materials that are required for systematic development of new research work.

This publication contains papers devoted to theoretical and experimental methods and to the determination of thermophysical properties of selected substances and materials. It also contains several papers dealing with the general method of formulating equations of state both for pure substances and for gas mixtures. Assessment is given of the precision of these data, and the limits of the range over which the data can vary are also identified.

The contents of the first volume were translated by IUPAC Thermodynamic Tables Project Centre, S. Angus, Director. They include:

Thermodynamic properties of carbon dioxide along the phase-equilibrium lines, by V. V. Altunin.
Dissociation, thermodiffusional relations, and thermodiffusional parameters, calculated by the method of similarity, by A. N. Berezhnoiy.
Experimental study of the density of liquid carbohydrates by the method of hydrostatic weighing, using strain gauges, by N. V.' Boiko and B. V. Voitiuk.
Concerning some forms of equation of state applying to liquids, by A. A. Wasserman and V. A. Rabinovich.
Velocity of sound in water steam, by A. A. Wasserman and V. I. Selevaniuk.
Calculation of thermodynamic properties of lithium, by L. D. Voljak.
Thermodynamic properties of solid mercury in the temperature range 0 K to the melting point at normal pressure, by M. P. Vukalovich, L. R. Fokin, and A. T. Jakovlev.
The velocity of sound in gaseous ethylene, by E. K. Dregulas and Ju. A. Soldatenko.
The equation of state for the natural gas from Beresan (Krasnodar region, West Caucasus) by A. M. Zhuravlev and V. A. Zagoruchenko.
Determination of the parameters of the transfer points for similar systems of gaseous mixtures, by Ya. Z. Kazavchinskii and V. I. Nedostup.
The Benedict-Webb-Rubin equation of state for butylene at pressures up to 40 bar, by S. D. Labinov and N. K. Bolotin.
Basic thermodynamic properties and characteristics of halogen derivatives of monosilane and methane, by I. I. Lapidus, L. A. Nisselson, and A. L. Seifer.
Temperature dependence of viscosity of dilute gases at high temperatures, by Ju. V. Mamonov and S. A. Ulybin.
The application of Lennard-Jones potential (12–6) of intermolecular interaction to the calculation of compressibility, viscosity, and heat conductivity of gaseous butylene, by I. A. Neduzhiy and N. K. Bolotin.
Experimental investigation of viscosity of gaseous ethylene and propylene, by I. A. Neduzhiy and Ju. I. Chamara.
Experimental investigation of viscosity of liquid propylene, isobutylene,1-3-butadiene, toluene and cyclohexane, by I. A. Neduzhiy and Ju. I. Chamara.
Tables of thermodynamic properties of carbon dioxide in the near-critical region, by V. A. Rabinovich.
Methods applicable to computerized calculation of thermochemical properties of the paraffin carbohydrates, by A. L. Seifer, E. A. Smolenskiy, and L. V. Kocharova.
Approximate method for calculating the molecular refractions and volumes of the compounds of the type $AR_1 \ldots R_k$, by E. A. Smolensky and A. L. Seifer.
Tables of thermodynamic properties of liquid ammonia, by G. I. Tzoyman.
Thermodynamic properties of hydrogen peroxide, by A. L. Tziykalo and A. G. Tabachnikov.
Generalized relations for the density of liquid base metals as functions of temperature, by E. E. Shpilrain and K. A. Jakimovich.

Two additional volumes in the thermodynamics area to be issued soon are:

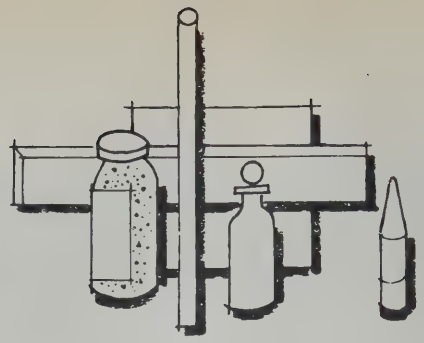
Vol. I Thermophysical properties of solids at high temperatures.
Vol. II Thermophysical properties of liquids, gases, and plasma at high temperatures.

## NSRDS Booklets

The Office of Standard Reference Data has made available two descriptive booklets about the National Standard Reference Data System. The first is *Q(uestions) and A(nswers) about the National Standard Reference Data System*, which provides a brief description of the history, mission, scope, activities and services of the program. The second is a *Publications List*, which provides a current listing of the publications issued by NSRDS. Both booklets are available on request from Information Services, Office of Standard Reference Data, Room A521, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

[1] Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.
[2] NSRDS News, NBS Tech. News Bull. 51, No. 10, 231 (Oct. 1967).

# STANDARD REFERENCE MATERIALS



*Standard Reference Materials are well-characterized materials disseminated by NBS to be used in calibrating and evaluating measuring instruments, methods, and systems or to produce scientific data that can be referred readily to a common base. These materials are certified for chemical composition or for a particular physical or chemical property. They are used on-site in science and industry for calibrating the instruments and methods used for production and quality control of raw materials, chemicals, metals, ceramics, fuels, and radioactive nuclides in manufacturing processes and in research. This column regularly reports on the issuance of new and renewal Standard Reference Materials and on latest developments in the Standard Reference Materials Program.*

This is the first of a series of articles that will review the various Standard Reference Materials applicable to specific areas of science, industry, and technology. Topics to be covered in this series include: problems that may be solved through use of SRM's; SRM's now available; new SRM's in process, and plans for future SRM's.

## CLINICAL AND BIOMEDICAL STANDARDS

Acting on requests from the American Association of Clinical Chemists (AACC) and the College of American Pathologists (CAP), the NBS Office of Standard Reference Materials has taken the first steps in becoming the national focal point for the preparation, certification, and issuance of clinical and biochemical standards for use in the Nation's clinical laboratories.

The need for standardization of clinical methods and instruments, which are now widely automated, was made dramatically apparent by the results of a national cholesterol survey sponsored by the CAP in 1963. As pointed out in the survey, the variability in test results was caused in large measure by systematic bias not only in a given method but also between different methods. A graph of the survey results is the background of the accompanying photograph showing the four clinical SRM's now issued by NBS: Cholesterol (SRM 911), Urea (SRM 912), Uric Acid (SRM 913), and Creatinine (SRM 914).

The determination of cholesterol in serum is widely used to predict chronic degenerative coronary artery disease. Results from clinical laboratories under close control have shown conclusively the value of this determination. The aim of CAP now is to translate the results of this research for all clinical and pathological laboratories in order to reduce interlaboratory variability of this and other similar clinical tests. This would permit the establishment of long-term base lines of serum cholesterol and other significant clinical parameters for a large number of individuals.

One of CAP's findings was that the cholesterol standards available before NBS issued its cholesterol standard varied in purity and were not suitable as primary standards.

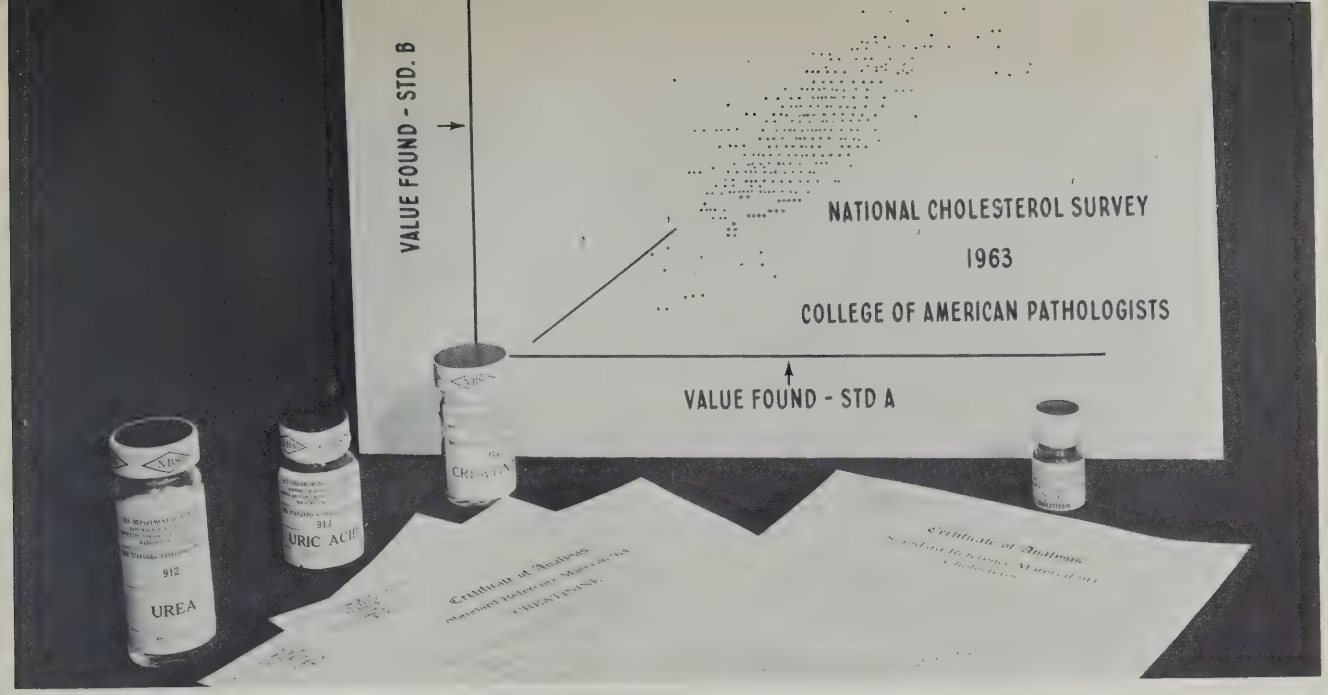
An estimated *750 to 1000 million* clinical tests are performed annually and the number is increasing at a rate of 10 to 15 percent each year. Of these tests, 60 to 75 percent are run on automated equipment. The key to providing meaningful, accurate results from this outpouring of data is the frequent calibration of equipment with suitable standards. Two recent papers [1,2] explore fully the problems of measurement and the use of SRM's in clinical chemistry.

### Primary Clinical Standards

Primary SRM's for clinical use must meet several specifications. They must have a high degree of purity (greater than 99 percent, in general); be free of substances that would interfere with standard clinical tests; and have a determinable shelf-life stability, which usually implies a stable substance of definite composition. The four SRM's now available from NBS meet these criteria. Each of these substances is a definite compound of known structure and, at the present state of knowledge, each is known to be free of major impurities that would interfere in standard clinical tests. Shelf-life stability tests now underway indicate a limited life of perhaps 2 to 3 years for the cholesterol SRM when stored under normal laboratory conditions. However, storage in an inert atmosphere at low temperatures may prolong shelf life.

The determination of the purity of these SRM's required many months of effort and involved such techniques as gas-liquid chromatography, thin-layer chromatography, mass spectrometry, infrared-ultraviolet spectroscopy, differential scanning calorimetry, nuclear magnetic resonance spectroscopy, and phase solubility analysis.

Although clinical chemists in the past have used the molar absorbance, under a given set of conditions, as a criterion of purity, scientists at NBS and elsewhere have shown this approach to have only limited value. A more thorough identification and characterization is required if the goal




*The graph behind the four NBS clinical SRM's shows the results of the 1963 National Cholesterol Survey. Over 1000 clinical laboratories were given two solutions (A and B) to determine their cholesterol values. The wide variations in results indicated a definite need for suitable standards.*

of primary SRM's for clinical use is to be achieved. Some discussion is underway to determine whether this philosophy can be practiced when enzymes, coenzymes, and proteins are studied for future clinical SRM's. When these materials are used under practical test conditions, the number of possible side reactions and the number of possible interfering species are greatly increased.

## Presently Available Clinical SRM's

Until November 1967 when NBS issued SRM 911, Cholesterol, no clinical SRM's were available from the Bureau. However, NBS SRM's for calibrating pH meters, oxidation-reduction titrimeters, and carbon-hydrogen-nitrogen analyzers were in limited use in some clinical laboratories, as were radioactivity SRM's for calibrating radioactivity counting equipment and spectrometers.

Each of the four clinical SRM's can be analyzed routinely on the automated analyzers, thus providing SRM's to standardize four of the 16 most frequently run clinical tests. Table 1 lists these 16 tests and gives examples of the body functions or malfunctions for which each is an indication.

In addition to the four SRM's certified specifically for clinical use, a number of other SRM's can be used in clinical, medical, or biological research laboratories. Many tests and analyses in these laboratories involve titration methods, measurement of reduction-oxidation potentials and pH, carbon-hydrogen-nitrogen analysis, and the calibration of radioactivity counters and spectrometers. Table 2 is a compilation of SRM's useful for these purposes.

## Clinical SRM's in Process

Measurement and certification of SRM's for sodium, potassium, chloride, calcium, glucose, and bilirubin are in process. The remaining items in table 1 involve measurement and certification by technical and scientific competences not now available at the Bureau. Providing SRM's for these additional items will depend in large measure on the rapidity with which these competences can be implemented. SRM's of steroids, enzymes, coenzymes, and proteins in-

TABLE 1. *Most frequent clinical tests**

| Clinical analysis | Diagnostic for: (examples) |
|---|---|
| Sodium, potassium, chloride, carbon dioxide | Ionic imbalance related to numerous illnesses—e.g., chronic kidney disease. |
| Calcium | Hyperparathyroidism. |
| Alkali phosphatase | Impaired liver function. |
| Glucose | Diabetes. |
| Cholesterol | Heart disease. |
| Urea, Creatinine | Renal malfunction. |
| Uric acid | Gout. |
| Bilirubin | Bile system malfunction. |
| Total protein | Hepatitis. |
| Enzymes (3) (e.g., glutarate-oxaloacetate transaminase). | Impaired liver function. |

*These tests account for 80 to 90 percent of all clinical analyses performed.

TABLE 2. *Available SRM's of clinical interest*

| SRM No. | Title | Certified use or value | Other potential use (not certified) |
|---|---|---|---|
| | | *Microanalytical standards* | |
| 140b | Benzoic acid | C, H analysis | Melting point. |
| 141b | Acetanilide | C, H, N analysis | Melting point. |
| 142 | Anisic acid | Methoxyl group analysis. | |
| 143b | Cystine | C, H, N, S analysis | Amino acid analysis. |
| 147b | Triphenyl phosphate | P analysis | |
| 148 | Nicotinic acid | C, H, N analysis | |
| 149 | o-Fluorobenzoic acid | F analysis | |
| | | *Primary chemicals* | |
| 17 | Sucrose | Polarimetric std | |
| 41a | Dextrose | Polarimetric std | Glucose analysis, reductometric std. |
| 40g | Sodium oxalate | Redox std | Calcium analysis (Clark-Collup method). |
| 83c | Arsenic trioxide | Redox std | Arsenic analysis. |
| 136b | Potassium dichromate | Redox std | Spectrophotometer calibration. |
| 84h | Acid potassium phthalate. | Acidimetric std | Potassium std.; osmolality std.; conductivity std.; photometric std. at 280.5 nm. |
| 350 | Benzoic acid | Acidimetric std | Melting point. |
| | | *Certified gas standards* | |
| 1609 | Oxygen in nitrogen | 20.95 mole % $O_2$ | |
| | | *Clinical analytical standards* | |
| 911 | Cholesterol | Purity 99.4% | |
| 912 | Urea | Purity 99.7% | |
| 913 | Uric acid | Purity 99.7% | |
| 914 | Creatinine | Purity 99.8% | |
| | | *pH and pD standards* | |
| 185d | Acid potassium phthalate. | pH 4.00 | |
| 186Ic | Potassium dihydrogen phosphate | Proper admixture give pH's of 6.87 or 7.41. | Potassium analysis. |
| 186IIb | Disodium hydrogen phosphate | | Phosphate analysis. |
| 187a | Borax | pH 9.18 | |
| 188 | Potassium hydrogen tartrate. | pH 3.56 | |
| 191 | Sodium bicarbonate | Proper admixtures give pH 10.04. | Electrolyte analysis. |
| 192 | Sodium carbonate | | |
| 2186I | Potassium dihydrogen phosphate | Proper admixture gives pD 7.43. | Electrolyte analysis. |
| 2186II | Disodium hydrogen phosphate | | |
| 2191 | Sodium bicarbonate | Proper admixture gives pD 10.74. | |
| 2192 | Sodium carbonate | | |
| | | *Calorimetric standards* | |
| 39i | Benzoic acid | Heat of combustion 26.734 absolute kilojoules. | Melting point. |
| 724 | Tris (hydroxymethyl) aminomethane. | Heat of solution | pH buffer. |
| | | *Radioactivity standards* | |
| Various* | 12 Radioactivity SRM's available as gamma-ray emitters; covers range from 0.088 MeV to 2.615 MeV. Point sources to calibrate counters and gamma-ray spectometers. | | |
| | | *Color standards* | |
| 2101–2105 (set) | Set of 5 glasses to check performance of spectrophotometer—tristimulus integrator systems. | | |
| 2106 | Centroid color chart | Standard color naming system. | |

*For detailed information, see Standard Reference Materials: Catalog and Price List of Standard Materials issued by the National Bureau of Standards, NBS Miscellaneous Publication 260 (1968 ed.), for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 45 cents.

volve problems in analysis, characterization, and stability which are an order of magnitude more difficult than those encountered in the relatively simple chemical SRM's heretofore issued.

In any measurement system, the final accuracy of the result is limited by the component having the largest inaccuracy. The one instrument universally used in clinical laboratories is the spectrophotometer. Here serious problems of wavelength and intensity calibration exist, and a significant part of the effort to establish accuracy in clinical analyses must be directed toward improving this link in the automated system.

Alkaline dichromate and oxidized nickel dimethylglyoxime, as well as other solutions, are being studied as possible SRM absorbance standards. Other factors affecting accuracy are also being studied—e.g., wavelength inaccuracy, absorbance scale nonlinearity, source and detector instability, slit width variations, and the effect of stray light. The ultimate goal is an SRM or series of SRM's, including glasses, that can be used to ensure the accurate calibration of the spectrophotometer.

A wide variety of well-characterized clinical SRM's can help to do for the "health industry" what they have done for the steel and rubber industries. Today, the quality of well over 90 percent of all the steel and rubber produced in the United States is controlled ultimately through the use of NBS SRM's, which were developed cooperatively between these industries and NBS over a period of many decades. That the quality of clinical test results needs to be improved is well documented and is not seriously questioned. Because of the urgency and immediacy of the problem, NBS hopes to accomplish this goal expeditiously by mounting a major effort in this area.

[1] Measurement and standard reference materials in clinical chemistry, by T. W. Mears and D. S. Young, Am. J. Clin. Path. **50**, 411–421, (1968).

[2] Ibid, by D. S. Young and T. W. Mears, Clin. Chem. **14**, 929–943 (1968).

### Selected Dissemination of Microfiche

A new subscription service for obtaining microfiche (sheet microfilm) copies of scientific and technical documents grouped by field of interest is now available. Customers of the Clearinghouse for Federal Scientific and Technical Information can order, from any of several hundred basic categories, unclassified reports and translations of foreign technical literature sponsored by over 100 Federal agencies and other organizations. Orders may be placed by subject category, by originating agency (DoD, NASA, AEC, etc.), or by subject category within an agency collection.

The new service, Selective Dissemination of Microfiche (SDM), provides a faster and more economical method for obtaining copies of the latest scientific and technical documents in selected fields of interest. It requires less effort for the user, as it will eliminate individual orders for documents.

Some examples of possible SDM selections are: All Department of Defense documents, all documents on electronics in all agency collections, or all documents on electronics in the NASA collection.

The automatic distribution feature of SDM permits the Clearinghouse to offer the new service at a price substantially lower than the standard Clearinghouse microfiche price of 65 cents per title. SDM distribution is made twice each month, starting this month, at the same time documents are announced for public sale by the Clearinghouse. SDM adds to the growing variety of Clearinghouse document services available to the scientific, industrial and technical public.

Detailed information on the categories, cost, and the method of ordering SDM are available upon request, from the SDM Desk (152.12), Clearinghouse for Federal Scientific and Technical Information, U.S. Department of Commerce, Springfield, Va. 22151.

### Desktop Analysis Tool

A computer-derived comprehensive index of names, molecular formulas, and principal sources of published data for some 33 000 chemical substances of importance in foodstuffs, drugs, pesticides, cosmetics, and related products is now available from the Clearinghouse. Called a Desktop Analysis Tool (DAT), the index was prepared by Chemical Abstracts Service (CAS).

The DAT makes available, in printed form, information in a special data collection established over the past 2 years as an experimental link between the CAS Chemical Registry System and the information systems of the Food and Drug Administration (FDA) and the National Library of Medicine (NLM). The information was compiled by CAS under a contract from the National Science Foundation, NLM, and FDA.

By establishing the chemical identity of each substance and relating them to the various names by which they are identified in the published literature, the DAT provides a bridge between data on these substances in some 60 published sources, including *Chemical Abstracts*, *Index Medicus*, and a variety of handbooks and standard reference works. Nearly 140 000 names are listed for the 33 000 substances covered.

The DAT is available in 5 volumes totaling 5300 pages. It is sold as PB 179 900 for $100.

### Scientific and Technical Data Activities in the United States

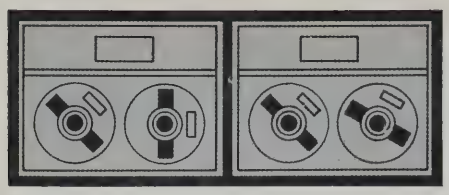
In July 1968, a $286 500 study of the scientific and technical data activities in the United States was completed by Dewitt O'Kelly Myatt and Bill Farris of Science Communication, Inc., Washington, D.C. The study was funded by the Advanced Research Projects Agency for the Committee on Scientific and Technical Information (COSATI) Task Group on National Systems, and was conducted under the monitorship of the Directorate of Information Sciences, Air Force Office of Scientific Research (AFOSR). The results of this effort are contained in *Study of Scientific and Technical Data Activities in the United States*, a three-volume publication totaling 1188 pages.

Volume I [1] (AD 670 606), 266 pages, presents a plan for the study and implementation of national scientific-and-technical-data-systems concepts.

Volume II [1] (AD 670 607), Parts A and B, 433 pages, presents summaries of data activities in 10 selected fields of science and technology: Aerospace science and technology, electronics and electrical engineering, materials science and engineering, chemistry and chemical engineering, agriculture and food technology, biomedical sciences, pharmacology, social and behavioral sciences, environmental and geosciences, and oceanography. The characteristics of data, data flows, formal data efforts, and representative data-related problems or issues identifiable with the field are covered.

Volume III [1] (AD 670 608), Part C, 489 pages, consists of a preliminary census of 226 formal data efforts

*continued p. 98*



# Information Processing

*In the fall of 1965 the Secretary of Commerce established the NBS Center for Computer Sciences and Technology to carry out the Secretary's responsibilities under the Brooks Bill (Public Law 89–306, passed October 30, 1965). The Center, under the direction of H. R. J. Grosch, provides leadership and coordination for Government efforts in the development of voluntary commercial information processing standards, develops recommendations for Federal information processing standards, performs required research and analysis, and provides scientific and technical support and consultative assistance in the field of computers and information processing to Federal agencies. These notes will cover information-processing standards activities in the Federal Government, particularly those of the Center.*

## IMPLEMENTATION OF CODE FOR INFORMATION INTERCHANGE

On March 7, 1969, Secretary of Commerce Maurice H. Stans issued detailed instructions to heads of Federal departments and agencies for the implementation of the Federal Standard Code for Information Interchange and related media standards.

These standards were approved as Federal Information Processing Standards by President Johnson on March 11, 1968, to take effect on July 1, 1969. The full text of both President Johnson's and Secretary Stans' memoranda will be provided by Federal Information Processing Standards Publication 7 (FIPS PUB 7) to be issued by the National Bureau of Standards in the near future. Secretary Stans' action is the latest of a series of steps taken to carry out the provisions of the Brooks Bill (Public Law 89–306), which has the objectives of economical and efficient purchase, lease, maintenance, operation, and utilization of automatic data processing equipment by Federal Government departments and agencies.

*Objectives.* The Federal information processing standards program contributes to the objectives of PL 89–306 through improved cost effectiveness, extension of the economic benefits of data processing, increased freedom of selection of data processing equipment, and greater flexibility in the use of equipment and programs provided by all suppliers. The basic necessities for achieving compatibility of information interchange are supplied by the new standards.

They include a standard character set, a standard coded representation thereof, a method of representing the coded character set in machine media, and a standard collating sequence. The new standards are to be used for the interchange of information in machine-processible form within and between information systems. They do not, however, extend to the internal structure of the central processing unit or peripheral devices.

*Coverage.* The standards and their implementing instructions apply to all computers and related equipment configurations brought into the Federal inventory or acquired or leased with Federal funds as set forth in Bureau of the Budget Circular A–54 revised June 27, 1967. They also apply to data systems developed for implementation by or for Government agencies, and to data developed outside the Federal Government at Government expense if such data are to be a part of the data base of a Federal agency. Related equipment includes all character-oriented equipment in which magnetic tape or perforated tape is produced for input to a computer-based data system or received as output from a computer-based data system. They also apply when transmission terminal equipment and facilities are procured primarily in support of a computer-based data system.

*Implementation Date.* The effective date is July 1, 1969. Transition from existing equipment is to be on an evolutionary basis as equipment is replaced or added, computers reprogramed and data systems redesigned. Instructions are provided for new installations, replacements of computers, augmentation of existing configurations, interchange situations, and ADP/telecommunications interfaces. Provision is made for certain specialized techniques such as pure binary, packed numerics, or floating point pending further standards development.

*Character Set.* The Federal Standard Code for Information Interchange defines a set of 128 characters commonly used in information processing and communications. It includes upper and lower case alphabets, numeric digits, punctuation marks, control characters, and special symbols. On nine-channel magnetic tape, seven channels are used for the code itself, one channel is recorded as zero, and one is used for a redundancy check. On eight-channel paper tape seven channels are used for the code and one for the redundancy check. Defined character set levels include a basic or standard set, subsets, extended sets, and expanded sets. Use of expanded or extended sets is made subject to prior approval and registration by NBS.

*Waivers.* When it appears that the introduction of the standard code would involve significant and continuing cost and efficiency disadvantages and when the interchange of information with other systems is minimal, waivers may

be granted. All waivers and reasons therefore are to be coordinated in advance with NBS. Waivers will generally not be required for equipment delivered before July 1, 1969, or for equipment ordered before March 11, 1968, for delivery on or after July 1, 1969.

## NOTES ON USASI COMMITTEES

The following notes on USASI Committees X3 and X4 are presented as part of the Center's responsibility in keeping the information processing community abreast of activities in the field of voluntary standards dealing with computers and information processing.

### X3 Notes

At its meeting in Phoenix, Ariz., January 23–24, 1969, the USASI X3 Committee on Computers and Information Processing formed a Composite Language Development Group. This Group is to study the composite language PL/I and produce a completed standards document for processing by X3 as a USA Standard. The Group is to coordinate with Technical Committee 2 of the International Federation for Information Processing (IFIP) and Technical Committee 10 of the European Computer Manufacturers Assoc. (ECMA) to assure that the composite language PL/I is compatible with other USA and International Organization for Standardization (ISO) standards.

The proposed ISO draft standard for ALGOL has been found to contain internal errors, and action thereon by the U.S.A. as a member-nation of ISO will be withheld pending necessary corrections.

The USASI COBOL X3.23 Standard is ready for publication, and will be published as soon as certain administrative questions can be resolved. A vote of appreciation was extended to R. E. Rountree and Mabel Vickers of the NBS staff for their dedicated efforts in support of this Standard.

Reorganization work for the X3 Committee has been passed from the X3 Systems Advisory Committee (X3/SAC) to the Business Equipment Manufacturers' Assoc. (BEMA) Procedures Committee. Tom Steele of Systems Development Corp. has been selected as Chairman of the new Standards Planning and Requirements Committee (SPARC).

ECMA has objected on technical grounds to proposed changes in the Tape Label Format. A joint meeting of USASI and ECMA representatives will be held to reconcile the differences.

A tutorial paper on a proposed 256-character Hollerith Card Code was released for publication and X3 letter ballot. It was noted that USASI attention should be called to this revision for the current USA Standard Hollerith Card Code X3.26-1968 (128 character). In addition, the proposed USA Standard Paper Card document was released for 60-day X3 letter ballot. The proposed USA Standard Data Communication Control Procedures for the USASCII was published in the March issue of *Communications of ACM*. A letter ballot will be taken 4 months after publication.

A written report was received from the X3.6 Committee on Problem Definition and Analysis Concerning Hand Printed Characters. The paper was approved for publication and referred to the X3.1 Committee on Optical Character Recognition for 60-day review. A ballot on this proposal will be considered at the next X3 meeting.

The Ad Hoc Committee on Interfaces was established as a standing, unnumbered X3 Committee. Consideration of the X3 Ad Hoc Committee on Coding Special Symbols of MICR and OCR was deferred pending a review of comments by X3/SAC.

X3 balloting on proposed Public Relations Procedures was extended to February 10.

USASI has called a meeting of interested persons regarding the Writing of Dates for Human Communications. This would develop a response to an ISO request for comment. The X3 Committee suggested a delay in USASI response to permit orderly X3 consideration.

The Universal Postal Union has proposed a ban on mailing of individual punched paper cards. At the moment, consideration by X3 of this action does not appear appropriate.

The request by Electronic Industries Assoc. to include their standards RS 244 and RS 358 covering Machine Tool Coding in the USASI Standards Index was deferred pending receipt of additional information.

### X4 Notes

The consideration of Keyboard Arrangement Standards proposals continues. Standards Committee X4-A9 had forwarded to X4 Office Machines Committee two proposals that covered an OCR Keyboard Arrangement and a bit-paired ASCII Keyboard Arrangement. Subsequent X4 balloting resulted in a "simple majority" for both proposed standards, although the U.S. Federal Government representatives voted against them in accordance with advice from Departments and Agencies. The Standards were then referred in September 1968 to the X4-A9 Committee for resolution of negative ballots and for recommended action.

X4-A9 responded in January 1969 with a proposal embracing a "family of keyboard arrangements" that included:

(1) a bit-paired (ASCII) arrangement,
(2) a non-bit-paired (ASCII) arrangement,
(3) a bit-paired data input arrangement for OCR,
(4) a non-bit-paired data input arrangement for OCR,
(5) an overlay arrangement with control keys—inboard,
(6) an overlay arrangement with control keys—outboard,
(7) the X4.7 Standard Typewriter Keyboard Arrangement, included as a reference keyboard.

At the January 29 meeting the X4 Committee accepted

*continued*

## INFORMATION PROCESSING *continued*

the "family concept" as presented and directed the X4-A9 Committee to proceed with preparation of a final USA Standards document for submission to USA Standards Institute. The action included instructions for an arrangement containing in a single keyboard all, or almost all, of the characters of USASI Standards X3.4 (ASCII), X3.17 (OCR), and X4.7 (Office Typewriter Keyboard).

### GAO REVIEW GUIDE

The U.S. General Accounting Office, Office of Policy and Special Studies, has issued a Review Guide for Evaluating Internal Controls in Automatic Data Processing Systems. The foreword states:

> This guide has been designed for use by GAO staffs in evaluating internal controls in ADP systems in Federal agencies or other organizations whose operations are being reviewed.
>
> The guide contains background information on controls used in ADP systems and a questionnaire for use in reviewing them.
>
> As more experience is gained in the review and evaluation of ADP systems in operation, the guide will be revised as necessary.

The section headings include:

I. Background Material on Controls Used in ADP Systems
II. Questionnaire for Use in Review of Internal Controls in ADP Systems
III. Trends in Automatic Data Processing and the Auditor
IV. Bibliography

The Bibliography contains 36 entries pertaining to descriptions of computing and ADP, programing, and audit practices in an ADP environment. Copies of the Review Guide can be obtained through the reports offices of the various Government agencies.

### STATUS OF FEDERAL INFORMATION PROCESSING STANDARDS RECOMMENDATIONS

First Phase: PROJECT NOMINATION
- Glossary of ADP Terms
- Time Sharing and Remote Console Considerations
- Hardware Interfaces
- Keyboard Configuration
- Synchronous Signalling Speeds

Second Phase: STANDARDS DEVELOPMENT
- Interchangeable Magnetic Disk Media
- RFP, RFQ, and Contract Formats
- OCR Measurement Technology
- OCR Paper
- ADP Systems Site Preparation
- Magnetic Tape Labels for Information Interchange
- Hollerith Punched Card Code (X3.26–1969)
- FORTRAN Standard Reference (X3.9–1966, X3.10–1966)
- COBOL Programing Language (X3.23–1968)
- Recorded Magnetic Tape for Information Interchange (200 CPI NRZI) (X3.14–1969)
- Character Sets for OCR Input (X3.17–1966)
- Layout of Forms for OCR Input
- Bit Sequencing of the USA Standard Code for Information Interchange in Serial-by-Bit Data Transmission (X3.15–1966)
- Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the USA Standard Code for Information Interchange (X3.16–1966)
- Signal Quality at Interface Between Data Processing Terminal Equipment and Synchronous Data Communication Equipment for Serial Data Transmission (X3.24–1966)
- Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication (X3.25–1968)

Third Phase: RECOMMENDATION FOR ADOPTION
- None

Fourth Phase: ISSUED FEDERAL INFORMATION PROCESSING STANDARDS
- FIPS 1 Code for Information Interchange (X3.4–1968)
- FIPS 2 Perforated Tape Code for Information Interchange (X3.6–1965)
- FIPS 3 Recorded Magnetic Tape for Information Interchange (X3.22–1967)
- FIPS 4 Calendar Date
- FIPS 5 States of the United States
- FIPS 6 Counties of the States of the United States

## CLEARINGHOUSE *continued*

that are representative of those currently operating in the United States. These include data service centers, data-document depositories, data program development and coordination, and data handling and service operations.

### COSATI Annual Report—1967

Efforts by Federal agencies during 1967 to provide readily available and universally interchangeable scientific and technical information are detailed in a report prepared by COSATI. *Progress of the United States Government in Scientific and Technical Communications, 1967* [1] (PB 180 867) presents the concepts, accomplishments, and problems encountered in the search for better methods of disseminating information.

### Guidelines to Format Standards

A 16-page pamphlet published by COSATI establishes guidelines for Federal agencies, contractors, and grantees in the preparation of scientific and technical reports. *Guidelines to Format Standards for Scientific and Technical Reports Prepared by or for the Federal Government* [1] (PB 180 600) was designed to increase the speed and effectiveness with which information is communicated among Federal agencies and to the public. By use of these Guidelines, an estimated savings of $10 million annually is expected through reduction of costs in the preparation, reproduction, and distribution of Government reports.

[1] Available from the Clearinghouse for Federal Scientific and Technical Information, U.S. Department of Commerce, Springfield, Va. 22151. Price for each document is $3 in paper copy and 65 cents in microfiche. Order by document number.

ing machine with a variable speed crosshead and electric load cell, which was connected to a chart recorder. Flat cylindrical plates were substituted for the upper and lower jaws in the machine. Pressure was exerted on the specimens through a cylindrical, flat indentor with a 1.125-in diameter.

For a test, the crosshead was lowered at a speed of 1 centimeter per minute until the chart indicated a load of approximately 100 kilograms. The crosshead was then immdeiately reversed, which yielded a compression-recovery curve.

The relative values for energy of compression were about as expected. Firm materials, such as asphalt and vinyl asbestos tile, showed low-energy values, while relatively high-energy values were obtained with soft materials, such as carpets with rubber cushions. However, the energy values were all low; none were more than a fraction of a foot pound (1 foot pound=1.36 joule).

This agrees with results from a study on the pressures on the human foot during walking.[1] In this study it was found that pressure variations due to changes in floor surface were almost nonexistent, the only noticeable effect being the disappearance of a small impact peak when the subject changed from ordinary floors (concrete, wood) to lawn. Surprisingly, the curve obtained for a relatively soft floor like cork tile was almost identical with the curves for wood and cement.

[1] Holden, T. S., and Muncey, R. W., Pressures on the human foot during walking, Austral. J. Appl. Sci. 4, No. 3, 405 (1953).

TABLE 1. *Laboratory measurements of static and rolling friction*

| Floor covering | Frictional force or load in pounds [a] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Hard rubber casters | | | | Soft rubber casters | | | |
| | Unloaded [b] | | 300 pound load [c] | | Unloaded [b] | | 300 pound load [c] | |
| | $P_S$ [d] | $P_R$ [e] | $P_S$ [d] | $P_R$ [e] | $P_S$ [d] | $P_R$ [e] | $P_S$ [d] | $P_R$ [e] |
| A—Vinyl asbestos tile | 11.1 | 5.3 | 24.6 | 13.1 | 12.0 | 8.8 | 28.1 | 21.2 |
| B—Sheet vinyl | 25.9 | 14.8 | 34.9 | 26.5 | 26.2 | 15.0 | 40.4 | 29.7 |
| C*—Nylon carpet | 20.1 | 15.1 | 41.3 | 31.3 | 18.0 | 13.4 | 36.4 | 28.0 |
| D*—Nylon carpet | 17.2 | 13.3 | 36.9 | 27.1 | 19.6 | 15.1 | 38.2 | 30.9 |
| E*—Nylon carpet | 23.8 | 17.8 | 47.7 | 35.8 | 26.0 | 20.0 | 47.4 | 36.1 |
| F*—Nylon carpet | 23.7 | 17.1 | 46.4 | 34.5 | 19.9 | 15.1 | 39.5 | 31.9 |
| G*—Nylon carpet | 33.3 | 24.9 | 60.8 | 46.4 | 30.4 | 22.1 | 52.7 | 41.0 |
| H*—Olefin carpet | 31.6 | 23.9 | 57.0 | 48.5 | 28.5 | 21.2 | 53.5 | 42.5 |
| I—Indoor-outdoor carpet | 24.1 | 18.2 | 46.8 | 36.2 | 25.5 | 19.2 | 46.5 | 38.0 |

[a] 1 pound force=4.45 newtons.
[b] Hospital bed, manually operated, with spring and mattress. Total weight 290 pounds.
[c] Hospital bed, weight 290 pounds, with additional 300 pounds weight.
[d] $P_S$=Static friction=Load in pounds required to produce motion. Maximum force recorded.
[e] $P_R$=Rolling friction=Load in pounds required to sustain motion. Average steady-state force recorded.
C*—Looped pile tufted without backing.
D*—Weave with sponge rubber cushion.
E*—Looped pile tufted, foam rubber cushion.
F*—Looped pile tufted, solid vinyl backing.
G*—Looped pile tufted, sponge vinyl cushion.
H*—With hair felt pad.

# PUBLICATIONS of the National Bureau of Standards*

## PERIODICALS

*Technical News Bulletin*, Volume 53, No. 3, March 1969, 30 cents. Annual subscription: Domestic, $3; foreign, $4. Available on a 1-, 2-, or 3-year subscription basis.

*Journal of Research of the National Bureau of Standards*

*Section A. Physics and Chemistry.* Issued six times a year. Annual subscription: Domestic, $6; foreign, $7.25. Single copy, $1.

*Section B. Mathematical Sciences.* Issued quarterly. Annual subscription: Domestic, $2.25; foreign, $2.75. Single copy, 75 cents.

*Section C. Engineering and Instrumentation.* Issued quarterly. Annual subscription: Domestic, $2.75; foreign, $3.50. Single copy, 75 cents.

## OTHER NBS PUBLICATIONS

Anderson, G. B., and Raybold, R. C., Studies of calibration procedures for load cells and proving rings as weighing devices, Tech. Note 436 (Jan. 1969), 30 cents.

Barnes, J. A., Tables of bias functions, $B_1$ and $B_2$, for variances based on finite samples of processes with power law spectral densities, Tech. Note 375 (Jan. 1969), 50 cents.

Boone, T. H., Skoda, L. F., and Cullen, W. C., Laboratory-field comparisons of built-up roofing membranes, Tech. Note 473 (Dec. 1968), 25 cents.

Brief history and use of the English and metric systems of measurement with a chart of the modernized metric system, one-third the dimensions of actual chart (SP 304), Spec. Publ. 304A 1968), 20 cents.

Bullis, W. M., Ed., Methods of measurement for semiconductor materials, process control, and devices, quarterly report July 1 to September 30, 1968, Tech. Note 472 (Dec. 1968), 50 cents.

Freeman, D. H., Ed., Separation and Purification Section: Summary of activities July 1967 to June 1968, Tech. Note 459 (Dec. 1968), 60 cents.

Gebbie, K. B., and Thomas, R. N., Eds., Wolf-Rayet stars, Proc. Symp., Joint Institute for Laboratory Astrophysics, University of Colorado, Boulder, June 10–14, 1968, Spec. Publ. 307 (Dec. 1968), $3.

Hermach, F. L., and Dziuba, R. F., Precision measurement and calibration. Selected NBS papers on electricity-low frequency, Spec. Publ. 300, Vol. 3 (Dec. 1968), $4.50. (Supersedes in part Handbook 77, Vol. I.)

Miles, B. M., and Wiese, W. L., Critically evaluated transition



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probabilities for Ba I and II, Tech. Note 474 (Jan. 1969), 30 cents.

Shields, W. R., Ed., Analytical Mass Spectrometry Section: Summary of activities July 1967 to June 1968, Tech. Note 456 (Nov. 1968), 55 cents.

The modernized metric system, the International System of units (SI) and its relationship to U.S. customary units, illustrated color wall chart 45 x 29 inches, Spec. Publ. 304 (1968), 50 cents. (Supersedes Misc. Publ. 232.)

White, H. S., Jr., Ed., General description of the Federal Information Processing Standards Register, Fed. Info. Process. Std. Pub. 0 (Nov. 1968), 20 cents.

White, H. S., Jr., Ed., Code for information interchange, Fed. Info. Process. Std. Pub. 1 (Nov. 1968), 10 cents.

White, H. S., Jr., Ed., Perforated tape code for information interchange, Fed. Info. Process. Std. Pub. 2 (Nov. 1968), 10 cents.

White, H. S., Jr., Ed., Recorded magnetic tape for information interchange (800 CPI, NRZI), Fed. Info. Process. Std. Pub. 3 (Nov. 1968), 10 cents.

White, H. S., Jr., Ed., Calendar date, Fed. Info. Process. Std. Pub. 4 (Nov. 1968), 20 cents.

White, H. S., Jr., Ed., States of the United States, Fed. Info. Process. Std. Pub. 5 (Nov. 1968), 20 cents.

White, H. S., Jr., Ed., Counties of the States of the United States, Fed. Info. Process. Std. Pub. 6 (Nov. 1968), 40 cents.

Youden, W. W., Computer literature bibliography. Vol. 2, 1964–1967, Spec. Publ. 309 (Dec. 1968), $5.

## PUBLICATIONS IN OTHER JOURNALS

*This column lists all publications by the NBS staff, as soon after issuance as practical. For completeness, earlier references not previously reported may be included from time to time.*

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